

DEVELOPMENT OF DC POWER SUPPLY USING POWER ELECTRONIC APPLICATIONS

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“I declare that this thesis entitled “Development of DC Power Supply Using Power Electronic Applications” is the result on my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidate of any of any other degree”

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ABSTRACT

This project is about how was to develop dc power supply using the applications of power electronic. In the power generation of most of electrical circuit, dc power supply is very required and demanded. It is familiarly to provide power for control and drive circuit within the main switchmode unit. Depending on the approaching of circuit design, the power supply will be common to either input or output of the circuit modeling. The design of DC power supply depends on the output of circuit design either single output or multiple output. There are different analysis to design the circuit based on the number of output. In this project, there are many applications of power electronics are applied such as transformer, AC to DC converter or rectifier, DC-DC converter, and semiconductor devices like power transistor. The circuit design approaching depends on the combination of these power electronic applications. The power supply designed is fully conversant with various combinations and its designer should be having capability to select the most appropriate for a particular application has indeed very powerful design tools.

ABSTRAK

Projek ini adalah mengenai bagaimana untuk mencipta pembekal kuasa arus terus dengan menggunakan aplikasi-aplikasi elektronik kuasa. Dalam penjanaan kuasa kebanyakan litar elektrik, pembekal kuasa arus terus sangat diperlukan dan mempunyai permintaan yang tinggi. Ia biasanya membekalkan kuasa untuk litar kawalan dan kendalian. Bergantung dengan pendekatan rekaan litar, pembekal kuasa ini secara umum untuk sama ada kemasukan atau keluaran model litar. Model litar pembekal kuasa arus terus bergantung ke atas keluaran rekaan litar sama ada satu keluaran atau banyak keluaran. Terdapat analisis berbeza untuk merekacipta litar itu berdasarkan jumlah keluaran yang dikehendaki. Dalam projek ini, terdapat beberapa aplikasi elektronik kuasa diguna-pakai seperti penukar arus ulang-alik kepada arus terus, penukar arus terus kepada arus terus, dan komponen semikonduktor seperti transistor. Pendekatan model litar ini bergantung kepada kombinasi aplikasi-aplikasi elektronik kuasa. Pembekal kuasa arus terus direka sepenuhnya dengan pelbagai kombinasi dan pereka tersebut mempunyai kemampuan sewajarnya dengan menggunakan peralatan-peralatan yang berkualiti.

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LIST OF ABBREVIATIONS

AC	-	Alternated Current
DC	-	Direct Current
LCD	-	Liquid Crystal Display
TNB	-	Tenaga Nasional Berhad
SESCO	-	Sarawak Electrical Supply Company
SESB	-	Sabah Electricity Sdn Bhd
SMPS	-	Switch-Mode Power Supply
LDO	-	Low Drop-Out
BJT	-	Bipolar Junction Transistor
CRT	-	Cathode Ray tube
TFT	-	Thin Film Transistor
PIC	-	Programmable Interface Controller
RAM	-	Random Access Memory

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CHAPTER 1

INTRODUCTION

1.1 Overview

Regulated dc power supplies are needed for most analog and digital electronic systems. Most power supplies are designed to meet some or all of the following requirements:

- Regulated output. The output voltage must be held constant within specified tolerance for changes within specified range in the input voltage and the output loading.
- Isolation. The output may be required to be electrically isolated from the input.

- Multiple outputs. There may be multiple outputs (positive or negative) that may differ in their voltage and current ratings. Such outputs may be isolated from each other.

In addition to these requirements, common targets are to reduce power supply size and weight and improve their efficiency[1]. Traditionally, linear power supplies have been used. However, advances in the semiconductor technology have lead to the switching power supplies, which are smaller and much more efficient compared to linear power supplies. The cost comparison between linear and switching supplies depends on the power rating.

1.2 Project Background

In this project, the report is explained about the circuit of dc power supply. It is made up of AC to AC converter and AC to DC converter as main components. AC to AC converter uses step-down transformer as the device. This transformer converts 240Vac to 24Vac for usage in the next stage. In the next stage, the voltage of 24Vac is converted to regulated DC voltage using AC to DC converter or bridge rectifier and its drive circuit. Bridge rectifier converts 24Vac to 24Vdc. After that, the voltage of 24Vdc converts to regulated DC voltage using drive circuit. In addition, the DC power supply interface to liquid crystal display (LCD) using PIC16F877 for voltmeter application.

1.3 Problem Statement

Nowadays, electrical power supply is the one of important element in human being needs. The most of human activities is very depending of demand of electrical power supply. In the other words, without electrical power supply, almost the whole of activities is become postponed or worse cancelled. There is some companies that responsible in distribute electrical power supply in Malaysia such as in peninsula of Malaysia is Tenaga Nasional Berhad(TNB), Sarawak is Sarawak Electrical Supply Company(ESCO), Sabah is Sabah Electrical Supply Berhad(ESB) and any private power supply provider. For usage of daily routine, voltage are supplied is within 240Vac. The problem happen is the most electrical appliances use DC voltage. Therefore, this voltage of 240Vac must be converted to desired DC voltage. Based on this problem, DC power supply is the solution of this problem.

1.4 Objective

The objective of this project is to;

- i. Develop circuit design of DC power supply using PROTEUS software
- ii. Develop hardware circuit based on the circuit design of DC power supply

1.5 Scope of Project

There are several scopes that need to be proposed for the project;

- i. This project is focused on AC to DC converter
- ii. The DC power supply circuit able convert fix voltage of 240Vac to desired dc voltage within 0V to 35V

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are two most familiar DC power supplies are used which are linear power supply and switching power supply[2]. Both the DC power supplies have their own differences based on the characteristics.

For linear power supply, it has the preceding discussion points out two major shortcomings of a linear power supply. It requires a low-frequency (60Hz) transformer. That means the size and weight of the transformer are larger than high-frequency transformer. Besides that, the transistors in linear DC power supply operate in active region, incurring a significant amount of power loss. It affected the overall efficiencies of linear power supply usually in a range of 30-60%.

There is different with the switching power supply. In this type of DC power supply, the switching elements such as power transistors or MOSFETs operate as a switch: either completely off and completely on. By avoiding the operation in active region, power loss of the system is able to reduce. As a result, its efficiency between 70-90% ranges. Since a high-frequency isolation transformer is used, the size and weight of switching power supplies can be significantly reduced.

2.2 Power Electronic Applications

2.2.1 Bridge Rectifier

A diode bridge is an arrangement of four (or more) diodes in a bridge configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating current (AC) input into direct current a (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding[11].

AC/DC power converters are extensively used in various applications like power supplies, dc motor drives, front-end converters in adjustable-speed ac drives, High Voltage Direct Current (HVDC) transmission, Switch-Mode Power Supply (SMPS), utility interface with non-conventional energy sources, in process technology like welding, power supplies for telecommunications systems, aerospace, military environment and so on[3]. Traditionally, AC–DC power conversion has been

dominated by diode or phase-controlled rectifiers which act as non-linear loads on the power systems and draw input currents which are rich in harmonics and have poor supply power factor, thus creating the power quality problem for the power distribution network and for other electrical systems in the vicinity of rectifier.

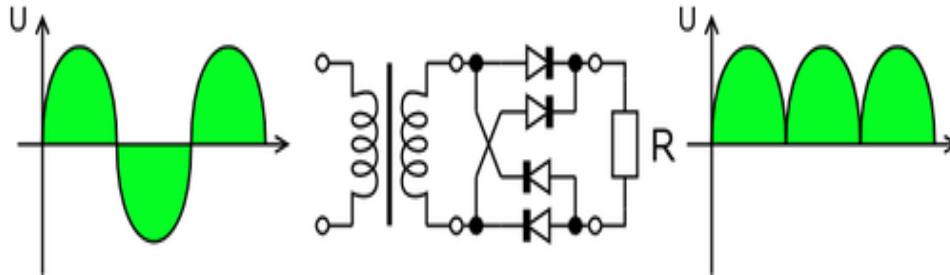


Figure 2.1 : The example circuit of rectifier [3]

According to the conventional model of current flow originally established by Benjamin Franklin and still followed by most engineers today, current is assumed to flow through electrical conductors from the positive to the negative pole[12]. In actuality, free electrons in a conductor nearly always flow from the negative to the positive pole. In the vast majority of applications, however, the actual direction of current flow is irrelevant. Therefore, in the discussion below the conventional model is retained. In the diagrams below, when the input connected to the left corner of the diamond is positive, and the input connected to the right corner is negative, current flows from the upper supply terminal to the right along the red (positive) path to the output, and returns to the lower supply terminal via the blue (negative) path like in Figure 2.2.

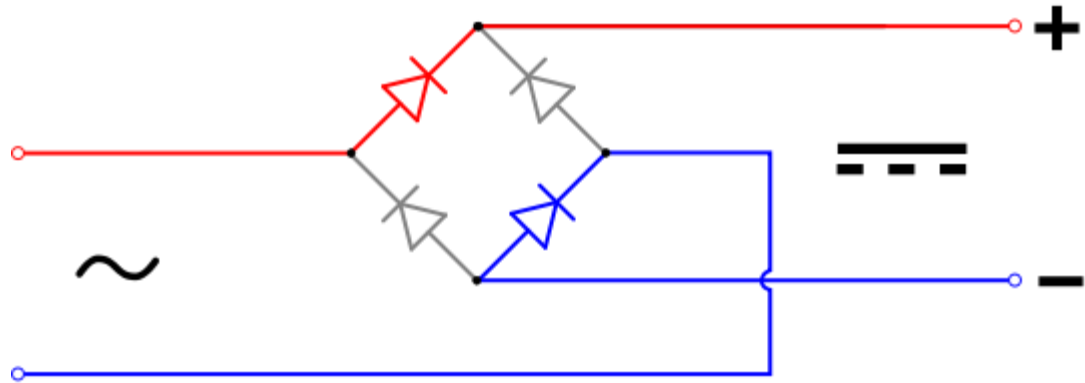


Figure 2.2 : Positive cycle of rectifier[11]

When the input connected to the left corner is negative, and the input connected to the right corner is positive, current flows from the lower supply terminal to the right along the red (positive) path to the output, and returns to the upper supply terminal via the blue (negative) path like in Figure 2.3.

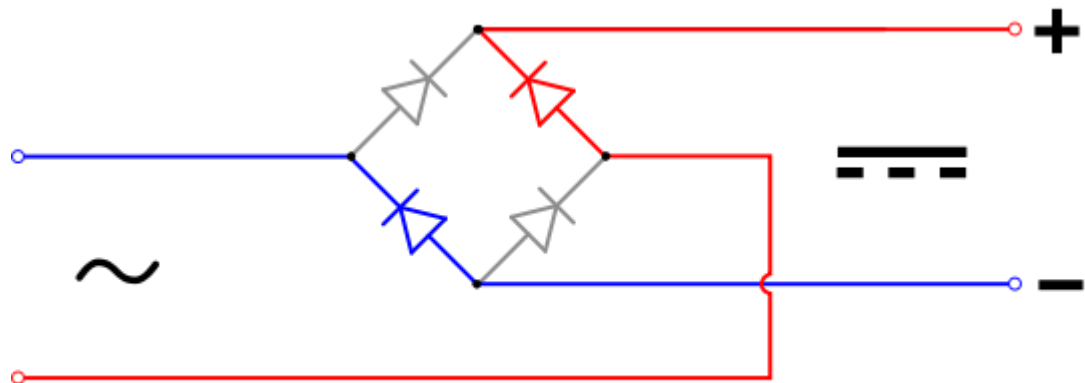


Figure 2.3: Negative cycle of rectifier[11]

In each case, the upper right output remains positive and lower right output negative. Since this is true whether the input is AC or DC, this circuit not only produces a DC output from an AC input, it can also provide what is sometimes called

"reverse polarity protection". That is, it permits normal functioning of DC-powered equipment when batteries have been installed backwards, or when the leads (wires) from a DC power source have been reversed, and protects the equipment from potential damage caused by reverse polarity.

For many applications, especially with single phase AC where the full-wave bridge serves to convert an AC input into a DC output, the addition of a capacitor may be desired because the bridge alone supplies an output of fixed polarity but continuously varying or "pulsating" magnitude, an attribute commonly referred to as "ripple".

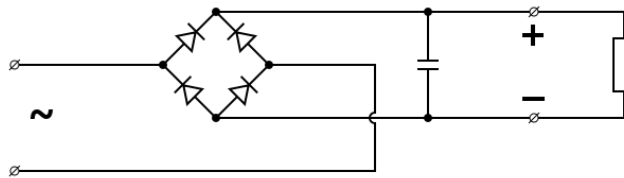


Figure 2.4 : A simple circuit of rectifier with load[12]

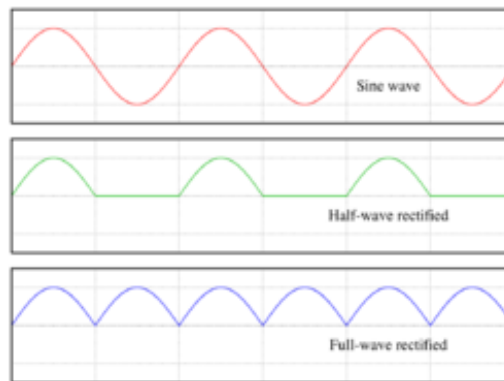


Figure 2.5 : AC, half-wave and full wave rectified signals[12]

2.2.2 DC to DC Converter

DC to DC converters are important in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored power is drained. Switched DC to DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing. Most DC to DC converters also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the input voltage.

The DC-DC converters are widely used in regulated switch-mode dc power supplies and in load drive applications. The input to these converters is an unregulated dc voltage, which is obtained by rectifying the line voltage and therefore it will fluctuate due to changes in the line voltage magnitude. Switch-mode DC-to-DC converters are used to convert the unregulated dc input into a controlled dc output at a desired voltage level. This is the basic block diagram of a DC-DC converter system:

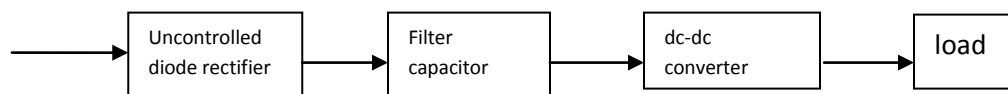


Figure 2.6 : Block diagram of DC-DC converter[4]